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DEVICE FOR MANUFACTURING LIQUID CRYSTAL PANEL

[Abstract]

PROBLEM TO BE SOLVED: To surely pressurize substrates to obtain a specified gap while the substrates are positioned with good accuracy and maintaining parallel to each other.

SOLUTION: One pressurizing plate 1 is moved upward and downward by a lifting member 4 so that one substrate A sucked and held on the pressurizing and sucking face 1a of the plate 1 approaches nearer to the other substrate B sucked and held on the pressurizing and sucking face 2a of the other pressurizing plate 2. While the proximity state is maintained, a flexible material 4 is elastically deformed to slightly move and tilt the one pressurizing plate 1 and one substrate A so that the one substrate A is

uniformly pressurized along the face of the other substrate B by the flat pressurizing and sucking face 1a of the pressurizing plate 1 made of a rigid body.

[Claims]

[Claim 1] A device for manufacturing a liquid crystal panel which pressurizes two upper and lower substrates A and B to have a predetermined gap, and bonds the two substrates A and B by hardening an adhesive C between the two substrates A and B, The device comprising: a pair of upper and lower pressurizing plates 1 and 2 being formed as a rigid body and having flat pressurizing adsorbing surfaces 1a and 2a on which the substrates A and B are respectively adsorbed; and a lifting/lowering member 3 for supporting any one of the pressurizing plates 1 and 2 to be freely reciprocated in the up/down direction with respect to the other plate, one pressurizing plate 1 being supported on the lifting/lowering member 3 to be freely inclined and transferred by elastic deformation of a flexible material 4.

[Claim 2] The device of claim 1, wherein a closed space 5 is formed between the lifting/lowering member 3 and the flexible material 4, and the flexible material 4 is elastically deformed so that one pressurizing plate 1 can be transferred in the up/down direction toward the other pressurizing plate 2 by a rise of an internal pressure of the closed space 5.

[Claim 3] The device of either claim 1 or 2, wherein a fluid 6 controlled in temperature is supplied to the closed space 5, for raising the internal pressure of the closed space 5.

[Claim 4] The device of any one of claims 1, 2 and 3, wherein any one of the pressurizing plates 1 and 2 is supported to be adjusted and transferred in the horizontal direction with respect to the other plate.

[Title of the Invention] Device for Manufacturing Liquid Crystal Panel

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to A device for manufacturing a liquid crystal panel which does not scatter spacers in a non-adhesive area between two substrates such as a panel for a liquid crystal projector, and more particularly to, A device for manufacturing a liquid crystal panel which precisely position-determines two upper and lower substrates, pressurizes the two substrates to have a predetermined gap, and bonds the two substrates by hardening an adhesive between the two substrates without positioning spacers.

[0002]

[Description of the Prior Art] A conventional liquid crystal panel is manufactured by spreading an adhesive between substrates in a frame shape, and scattering spacers on the whole surfaces thereof, so that both substrates can be easily pressurized to have a predetermined gap. Since an image transmitting a panel for a liquid crystal projector is enlarged, the spacers existing in a screen area are also enlarged. Therefore, the spacers cannot be scattered inside the spreading position of the adhesive.

[0003]

[Problems to be Solved by the Invention] However, when one substrate is pressurized toward the other fixed substrate by a flexible material such as a thin plate or a film, the center portions of the substrates cannot be supported by the spacers. Accordingly, the center portions of the substrates are caved, and the center portion of the panel has a concave

surface without the predetermined gap.

[0004] An object of the present invention as recited in Claim 1 is to precisely position-determine both substrates, maintain the two substrates in parallel, and pressurize the two substrates to have a predetermined gap. In addition to the object of the present invention as recited in Claim 1, an object of the present invention as recited in Claim 2 is to pressurize both substrates in micron units to have a predetermined gap without operating a lifting/lowering member. In addition to the object of the present invention as recited in Claim 1 or 2, an object of the present invention as recited in Claim 3 is to prevent deformation of the upper and lower substrates by temperature rise. In addition to the object of the present invention as recited in Claim 1, 2 or 3, an object of the present invention as recited in Claim 4 is to position-determine the upper and lower substrates and pressurize both substrates with a predetermined gap by using one apparatus.

[0005]

[Means for Solving the Problem] In order to achieve the aforementioned objects of the present invention, A device for manufacturing a liquid crystal panel as recited in Claim 1 includes: a pair of upper and lower pressurizing plates being formed as a rigid body and having flat pressurizing adsorbing surfaces on which the substrates are respectively adsorbed; and a lifting/lowering member for supporting any one of the pressurizing plates to be freely reciprocated in the up/down direction to the other plate. Here, one pressurizing plate is supported on the lifting/lowering member to be freely inclined and transferred by elastic deformation of a flexible material.

In addition to the structure of Claim 1, in The device for manufacturing the liquid crystal panel as recited in Claim 2, a closed space is formed between the lifting/lowering member and the flexible material, and the flexible material is elastically deformed so that one pressurizing plate can be transferred in the up/down direction toward the other pressurizing plate by rise of an internal pressure of the closed space.

In addition to the structure of Claim 1 or 2, in The device for manufacturing the liquid crystal panel as recited in Claim 3, a fluid controlled in temperature is supplied to the closed space, for raising the internal pressure of the closed space.

In addition to the structure of Claim 1, 2 or 3, in The device for manufacturing the liquid crystal panel as recited in Claim 4, any one of the pressurizing plates is supported to be adjusted and transferred in the horizontal direction to the other plate.

[0006]

[Operation]

In the present invention of Claim 1, one pressurizing plate is transferred in the up/down direction by a lifting/lowering member, and one substrate adsorbed on a pressurizing adsorbing surface of the pressurizing plate approaches the other substrate adsorbed on a pressurizing adsorbing surface of the other pressurizing plate. In the approach state, a flexible material is elastically deformed to slightly incline and transfer one pressurizing plate and the other substrate. Accordingly, one substrate is evenly pressurized on the flat pressurizing adsorbing surface of the pressurizing plate formed as a rigid body along the surface of the other

substrate. In addition to the structure of Claim 1, in the present invention of Claim 2, a closed space is formed between the lifting/lowering member and the flexible material, and the flexible material is elastically deformed so that one pressurizing plate can be transferred in the up/down direction toward the other pressurizing plate by rise of an internal pressure of the closed space. Since the flexible material is elastically deformed by rise of the internal pressure of the closed space, one pressurizing plate is downwardly transferred in micron units toward the other pressurizing plate. In addition to the structure of Claim 1 or 2, in the present invention of Claim 3, a fluid controlled in temperature is supplied to the closed space, for raising the internal pressure of the closed space. Therefore, the upper and lower substrates are cooled with one pressurizing plate therebetween. In addition to the structure of Claim 1, 2 or 3, in the present invention of Claim 4, any one of the pressurizing plates is supported to be adjusted and transferred in the horizontal direction to the other plate. The upper and lower substrates are precisely position-determined by adjusting and transferring any one of the pressurizing plates in the horizontal direction to the other pressurizing plate. Thereafter, the position-determined upper and lower substrates are pressurized to have a predetermined gap.

[0007]

[Embodiment of the Invention] The preferred embodiments of the present invention will now be described in detail with reference to the accompanying drawings. As illustrated in Figs. 1(a) and 1(b), an upper pressurizing plate 1 is supported in a floating island shape on a center of a bottom surface of a lifting/lowering member 3 with a flexible material 4 therebetween, and a

lower pressurizing plate 2 is fixed not to be movable. In a state where two upper and lower glass substrates A and B are adsorbed on flat pressurizing adsorbing surfaces 1a and 2a of the pressurizing plates 1 and 2, respectively, the lifting lowering member 3 is lowered so that the upper substrate A can approach the lower substrate B.

[0008] The upper and lower pressurizing plates 1 and 2 are formed as a rigid body. The flat pressurizing adsorbing surface 1a facing the surface of the upper substrate A is formed on the bottom surface of the upper pressurizing plate 1, and the flat pressurizing adsorbing surface 2a facing the bottom surface of the lower substrate B is formed on the surface of the lower pressurizing plate 2.

[0009] In this embodiment, the upper pressurizing plate 1 is formed as a rigid body such as metal or ceramic, and the lower pressurizing substrate 2 is formed as a transparent rigid body such as quartz. An ultraviolet light source (not shown) is installed at the lower portion of the lower pressurizing plate 2.

[0010] Suction holes 1b and 2b are formed on the upper and lower pressurizing plates 1 and 2. The suction holes 1b and 2b are linked to a suction source (not shown) through suction paths 1c and 2c formed in the pressurizing plates 1 and 2.

[0011] A suction device 1d that is a curved means is connected to the suction path 1c formed in the upper pressurizing plate 1. The suction device 1d is linked to an air suction source (not shown) through a suction path 3c formed in the lifting/lowering member 3 discussed later.

[0012] The operation of the air suction source (not shown) is controlled by

a control unit (not shown). The air suction source starts air suction in the bonding operation of the upper and lower substrates A and B, thereby adsorbing the surface of the upper substrate A and the bottom surface of the lower substrate B supplied to a transfer means (not shown) in the preceding process on the pressurizing adsorbing surfaces 1a and 2a. In addition, the air suction source cancels air suction after hardening an adhesive C, thereby disconnecting the substrates A and B from the pressurizing adsorbing surfaces 1a and 2a.

[0013] The lifting/lowering member 3 for supporting the upper pressurizing plate 1 is supported by a lifting/lowering device (not shown) such as a driving cylinder. In this embodiment, the lifting/lowering member 3 is also adjusted and transferred in the horizontal direction by an adjusting device (not shown).

[0014] The operation of the lifting/lowering device (not shown) is controlled by the control unit. In the initial state, the lifting/lowering device disposes the lifting/lowering member 3 in the top limit position. After the upper and lower substrates A and B are adsorbed on the pressurizing adsorbing surfaces 1a and 2a, the lifting/lowering device downwardly transfers the lifting/lowering member 3 and the upper pressurizing plate 1. When the upper substrate A does not contact the lower substrate B but approaches the lower substrate B with the adhesive C therebetween, the lifting/lowering device stops the lifting/lowering member 3 and the upper pressurizing plate 1. In the downward approach state, the adjusting device (not shown) is manually operated so that only the lifting/lowering member 3 can be upwardly transferred to the initial state after pressurization of the upper and

lower substrates A and B.

[0015] In this embodiment, a concave unit 3a is formed on the bottom surface of the lifting/lowering member 3 facing the upper pressurizing plate 1. The upper pressurizing plate 1 is supported on the center of the concave unit 3a to be freely inclined and transferred with the flexible material 4 therebetween. A closed space 5 is formed by the concave unit 3a and the flexible material 4.

[0016] For example, the flexible material 4 is a thin plate made of metal such as stainless steel and elastically deformable. The flexible material 4 is formed in a frame shape with its center portion opened. The outer circumference of the flexible material 4 is connected to the inner circumference of the concave unit 3a, and the inner circumference of the flexible material 4 is connected to the outer circumference of the upper pressurizing plate 1. When the lifting/lowering member 3 is adjusted and transferred in the horizontal direction by the adjusting device (not shown), the upper pressurizing plate 1 follows the lifting/lowering member 3 without an operational delay or error. In this embodiment, the flexible material 4 is disposed to approach the pressurizing adsorbing surface 1a of the upper pressurizing plate 1 as much as possible.

[0017] In addition, a supply path 3b inked to a supply source (not shown) of a fluid 6 such as water or compressed air is formed on the lifting/lowering member 3. After the upper and lower substrates A and B are position-determined, the supply source supplies the fluid 6 to the closed space 5 through the supply path 3b. The flexible material 4 is elastically deformed by rise of the internal pressure of the closed space 5. Therefore, the upper

pressurizing plate 1 is slightly downwardly transferred in micron units to the lower pressurizing plate 2. In this embodiment, cold water having a lower temperature than a set temperature is supplied to the closed space 5 as the fluid 6.

[0018] On the other hand, the upper and lower substrates A and B are two substrates having target patterns. An ultraviolet hardening adhesive C is spread in a frame shape on the bottom surface of the upper substrate A, and position-determining marks (not shown) are installed on the outer circumference thereof. Here, one edge is formed by the adhesive C, which is not intended to be limiting. That is, when the upper and lower substrates A and B are formed in a large size, the plurality of edges of the adhesive are arranged between the substrates A and B, for assembling a plurality of liquid crystal panels at the same time.

[0019] The operation of The device for manufacturing the liquid crystal panel will now be described. At the early stage, as indicated by an one-point long dotted line of Fig. 1(a), the lifting/lowering member 3 is maintained in the top limit position. The surface of the upper substrate A is adsorbed on the flat pressurizing adsorbing surface 1a of the upper pressurizing plate 1 and the bottom surface of the lower substrate B is adsorbed on the flat pressurizing adsorbing surface 2a of the fixed lower pressurizing plate 2 by air suction of the air suction source (not shown).

[0020] As indicated by a solid line of Fig. 1(a), the lifting/lowering member 3 is downwardly transferred from the top limit position by the lifting/lowering device (not shown), and thus the upper substrate A is downwardly transferred. The bottom surface of the upper substrate A does not contact

the lower substrate B but approaches the lower substrate B with the adhesive C therebetween.

[0021] In the approach state, as indicated by a two-point long dotted line of Fig. 1(a), when the lifting/lowering member 3 is adjusted and transferred in the horizontal direction, namely, in the XYθ direction by the manual operation of the adjusting device (not shown), the upper pressurizing plate 1 follows the lifting/lowering member 3 without an operational delay or error.

[0022] As a result, the upper and lower substrates A and B are precisely position-determined by using the position-determining marks (for example, precision below ±0.5μm when the substrates A and B have a diagonal length of 1 to 4 inches (2.54 to 10.56cm)).

[0023] In this embodiment, the flexible material 4 is disposed to approach the pressurizing adsorbing surface 1a of the upper pressurizing plate 1. When the upper and lower substrates A and B are position-determined by adjusting and transferring the upper pressurizing plate 1 in the horizontal direction by the lifting/lowering member 4, although the pressurizing adsorbing surface 1a on which the upper substrate A is adsorbed is more protruded to the lower pressurizing plate 2 than the flexible material 4, moment is not generated and the pressurizing adsorbing surface 1a is not seriously inclined to the flexible material 4. As a result, both substrates A and B can be precisely position-determined.

[0024] After the substrates A and B are position-determined, as shown in Fig. 1(b), in the XYθ direction, the fluid 6 is supplied from the supply source (not shown) to the closed space 5 formed between the supply path 3b of the lifting/lowering member 3 and the flexible material 4.

[0025] When the internal pressure of the closed space 5 reaches an appropriate pressure by pressurizing the upper pressurizing plate 1, the flexible material 4 is elastically deformed to slightly downwardly transfer the upper pressurizing plate 1 in micron units.

[0026] When the upper pressurizing plate 1 is slightly downwardly transferred, the adsorbed upper substrate A is slightly downwardly transferred in the Z direction. The bottom surface of the upper substrate A contacts the surface of the lower substrate B adsorbed on the fixed lower pressurizing plate 2 with the adhesive C therebetween. Both substrates A and B are pressurized with a predetermined gap.

[0027] Accordingly, both substrates A and B can be pressurized in micron units to have a predetermined gap without operating the lifting/lowering member 3. As compared with the case of pressurizing both substrates A and B in micron units by mechanically lifting or lowering the lifting/lowering member 3 by the lifting/lowering device (not shown), The device can be simplified in structure.

[0028] Here, when the upper substrate A downwardly transferred by the upper pressurizing plate 1 is not completely paralleled in micron units to the lower substrate B adsorbed on the fixed lower pressurizing plate 2, and when the adhesive C formed on the bottom surface of the upper substrate A partially contacts the surface of the lower substrate B by inclination of the upper and lower substrates A and B, the flexible material 4 is elastically deformed to incline and transfer the upper pressurizing plate 1 and the upper substrate A.

[0029] Therefore, the bottom surface of the upper substrate A is evenly

pressurized on the flat pressurizing adsorbing surface 1a of the upper pressurizing plate 1 formed as a rigid body along the surface of the lower substrate B. As a result, both substrates A and B can be precisely position-determined, maintained in parallel, and pressurized with a predetermined gap. For example, when the substrates A and B have a diagonal length of 1 to 4 inches (2.54 to 10.56cm), the gap is smaller than ±0.3μm.

[0030] In a state where both substrates A and B maintain the predetermined gap, ultraviolet rays are irradiated from the ultraviolet light source (not shown) to the ultraviolet hardening adhesive C between the upper and lower substrates A and B through the transparent lower pressurizing plate 2. Therefore, the ultraviolet hardening adhesive C is hardened so that the upper and lower substrates A and B can be bonded without spacers. In addition, the upper and lower substrates A and B are position-determined and pressurized with a predetermined gap by using one apparatus.

[0031] Especially, when cold water having a lower temperature than a set temperature is supplied to the closed space 5 as the fluid 6, the upper and lower substrates A and B are cooled with the upper pressurizing plate 1 therebetween. It is thus possible to prevent deformation of the upper and lower substrates A and B by temperature rise.

[0032] On the other hand, Figs. 2(a) and 2(b) illustrate A device for manufacturing a liquid crystal panel in accordance with another embodiment of the present invention. An upper pressurizing plate 1' is fixed not to be movable, and a lower pressurizing plate 2' is supported in a floating island shape on a center of a surface of a lifting/lowering member 3' with a flexible material 4' therebetween. In a state where upper and lower substrates A

and B are adsorbed on flat pressurizing adsorbing surfaces 1a' and 2a' of the pressurizing plates 1' and 2', respectively, the lifting lowering member 3' and the lower pressurizing plate 2' are lifted so that the lower substrate B can approach the upper substrate A. Except this, the structure of Figs. 2(a) and 2(b) is identical to the structure of Figs. 1(a) and 1(b). In addition, a fluid 6' is supplied to a closed space 5' formed between the lifting/lowering member 3' and the flexible material 4', for raising the internal pressure of the closed space 5'. Therefore, the flexible material 4' is elastically deformed so that the lower pressurizing plate 2' can be slightly upwardly transferred toward the upper pressurizing plate 1'.

[0033] Identically to the embodiment of Figs. 1(a) and 1(b), both substrates A and B are precisely position-determined, maintained in parallel, and pressurized to have a predetermined gap.

[0034] In the above embodiment, after the upper and lower substrates A and B are position-determined, the flexible material 4 is elastically deformed by rise of the internal pressure of the closed space 5, and thus one pressurizing plate 1 is slightly downwardly transferred toward the other pressurizing plate 2. It is not intended to be limiting. For example, the flexible material 4 is elastically deformed by mechanically lifting or lowering the lifting/lowering member 3 in micron units, so that one pressurizing plate 1 and the other substrate A can be slightly inclined and transferred and the upper and lower substrates A and B can be pressurized with a predetermined gap.

[0035] In the above embodiment, the upper pressurizing plate 1 is supported to be adjusted and transferred in the horizontal direction to the

lower pressurizing plate 2 by the lifting/lowering member 3. It is not intended to be limiting. For example, the upper and lower substrates A and B are position-determined by supporting the lower pressurizing plate 2 to be adjusted and transferred in the horizontal direction to the lifting/lowering member 3 and the upper pressurizing plate 1, and adjusting and transferring the lower pressurizing plate 2 in the horizontal direction. In addition, in the above embodiment, the ultraviolet rays are irradiated to harden the ultraviolet hardening adhesive C between the upper and lower substrates A and B, which is not intended to be limiting. For example, an adhesive made of a thermally-tempered resin can be heated and hardened.

[0036]

[Effect of the Invention] As discussed earlier, in the present invention of Claim1, one pressurizing plate is transferred in the up/down direction by the lifting/lowering member, and one substrate adsorbed on the pressurizing adsorbing surface of the pressurizing plate approaches the other substrate adsorbed on the pressurizing adsorbing surface of the other pressurizing plate. In the approach state, the flexible material is elastically deformed to slightly incline and transfer one pressurizing plate and one substrate. Thus, one substrate is evenly pressurized on the flat pressurizing adsorbing surface of the pressurizing plate formed as a rigid body along the surface of the other substrate. Accordingly, both substrates can be precisely position-determined, maintained in parallel, and pressurized with a predetermined gap. In the conventional art, when the substrates are pressurized, the center portions of the substrates which are not supported by the spacers are caved not to obtain a predetermined gap. In the present

invention, the gap can be precisely formed between the substrates without using the spacers.

[0037] In addition to the structure of Claim 1, in the present invention of Claim 2, the flexible material is elastically deformed by rise of the internal pressure of the closed space, so that one pressurizing plate can be downwardly transferred to the other pressurizing plate in micron units. Both substrates are pressurized in micron units to have a predetermined gap without operating the lifting/lowering member. Therefore, as compared with the case of pressurizing both substrates in micron units by mechanically lifting or lowering the lifting/lowering member, The device can be simplified and miniaturized in structure. Also, manufacturing expenses of The device can be cut down.

[0038] In addition to the structure of Claim 1 or 2, in the present invention of Claim 3, the upper and lower substrates are cooled with one pressurizing plate therebetween. It is thus possible to prevent deformation of the upper and lower substrates by temperature rise.

[0039] In addition to the structure of Claim 1, 2 or 3, in the present invention of Claim 4, the upper and lower substrates are precisely position-determined by adjusting and transferring any one of the pressurizing plates in the horizontal direction to the other plate. Moreover, the upper and lower substrates can be position-determined and pressurized with a predetermined gap by using one apparatus.

[Description of Drawings]

[Fig. 1] is a longitudinal front view illustrating A device for manufacturing a liquid crystal panel in accordance with a first embodiment of the present

invention, wherein Fig. 1(a) shows position-determination of both substrates and Fig. 1(b) shows pressurization of both substrates.

[Fig. 2] is a longitudinal front view illustrating A device for manufacturing a liquid crystal panel in accordance with a second embodiment of the present invention, wherein Fig. 2(a) shows position-determination of both substrates and Fig. 2(b) shows pressurization of both substrates.

[Explanation of Reference Numerals] A and B substrates, C adhesive, 1 and 2 pressurizing plates, 1a and 2a pressurizing adsorbing surfaces, 3 lifting/lowering member, 4 flexible material, 5 closed space, 6 fluid